ABSTRACT

An actively-cooled, fiber-reinforced ceramic matrix composite thrust chamber for liquid rocket propulsion systems is designed and produced with internal cooling channels. The monocoque tubular structure consists of an inner wall, which is fully integrated to an outer wall via radial coupling webs. Segmented annular void spaces between the inner wall, outer wall and adjoining radial webs form the internal trapezoidal-shaped cooling channel passages of the tubular heat exchanger. The manufacturing method enables producing any general tubular shell geometry ranging from simple cylindrical heat exchanger tubes to complex converging-diverging, Delaval-type nozzle structures with an annular array of internal cooling channels. The manufacturing method allows for transitioning the tubular shell structure from a two-dimensional circular geometry to a three-dimensional rectangular geometry. The method offers the flexibility of producing internal cooling channels of either constant or continuously variable cross-sectional area, in addition to orienting the cooling channels either axially, helically or sinusoidally (e.g., undulating) with respect to the longitudinal axis of the tubular shell structure with without significant added manufacturing complication.